THE POSTGLACIAL CONNECTICUT AT TURNERS FALLS, MASS.

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THE familiar slabs of sandstone with fossil footprints from Turners Falls come chiefly from the "Bird Track Quarry," about a mile from that village on the opposite side of the Connecticut River.[1]

The quarry is on the west shore of a little sheet of water known as the Lily Pond, which is steeply walled with rocks on three sides, opening on the north to a tract of marsh and a stagnant arm of the river called the Cove. These details are clearly shown in Fig. 2, giving on a large scale the actual topography of the region about *A* and *B* in Fig. 1. Fig. 2 is *not* taken from the state map.

The Lily Pond is the pool of an abandoned waterfall made by the Connecticut some time since the last glacial epoch, and occupied long enough for it to cut back an eighth of a mile in the Triassic sandstone. When this path was abandoned the river was fifty feet above its present bed. Fig. 3 shows one wall of the little gorge at the point where the quarry is situated, looking across the pond from the opposite side. The quarry is just beneath the pine tree in the center, the rejected slabs forming the talus heap below.

[1] *A*, Fig. 1.

The rocks about the pool are waterworn in precisely the same way as the similar sandstones beneath the present falls at the village. The edges of the shaly laminæ are frayed and rounded

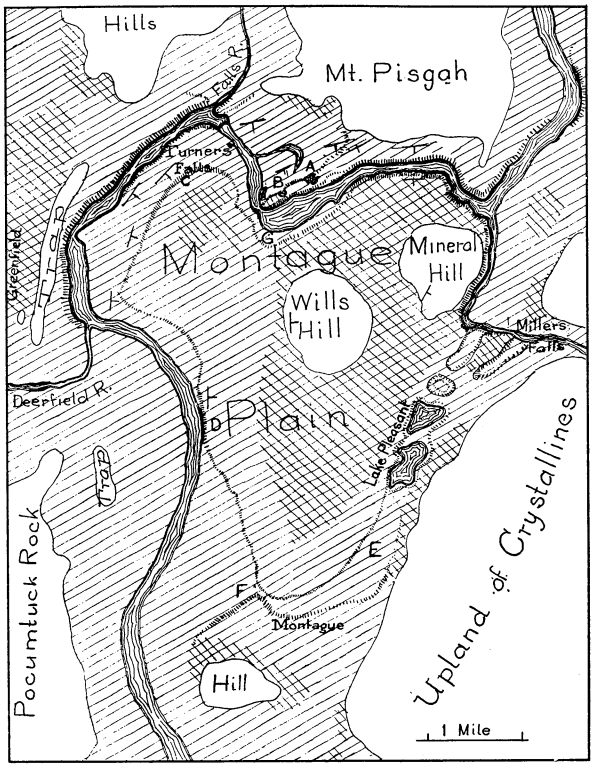

FIG. 1.

as appears in Fig. 4, which is a view of *P* looking from *O* in Fig. 2. Similar effects are observed on all the rocks about.

Besides this fraying of edges, a clear indication of water action, is the complete absence of glaciation about the pool, though elsewhere these sandstones and shales show unmistakable smoothing and grooving on every ledge. Here, despite the rounding in detail, the mass contours of the rocks are sharp and jagged. They have been deglaciated in the rush of waters.

Half a mile further southwest along the same ridge of red shales is Poag's Hole, a similar gorge, somewhat deeper, but of comparable area. Fig. 5 shows the western rock wall. The

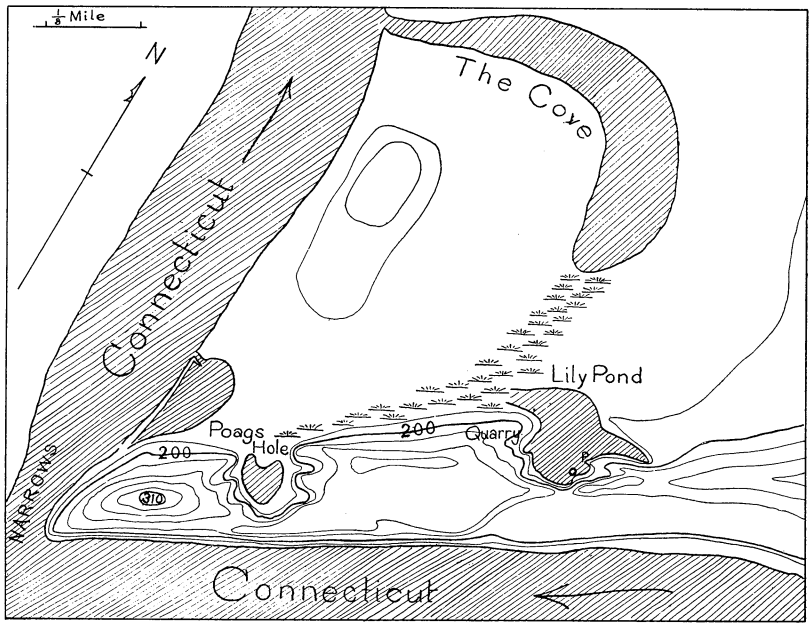

FIG. 2.

crest of the wall at the back is about twenty feet above the crest at the Lily Pond and the sills in front of the pools have nearly the same difference of level. This fall, then, was cut by the river earlier than that at the Lily Pond.

The ridge in which these two gorges are cut has a northern front of exposed shales and sandstones, which strike a little north of east and dip moderately to south. The strata are continuous across the gorges and were once everywhere overlain by clays under sands and gravels, all of glacial origin. The clays are now exposed in the 270-foot flat on the south side of the ridge, between Poag's Hole and Lily Pond. The highest point on the

promontory, west of Poag's Hole, is a cap of gravelly sands that bring it up to the level of Montague Plain, of which it was doubtless once a part, most of the sand and clay having been

FIG. 3.

removed by the river as it cut its way down toward the rock. Fig. 6 is a section through the highest point of the ridge just west of Poag's Hole,

Montague Plain is roughly outlined in Fig 1, the single-lined area suggesting the original extent of the plain formation, and the cross lined part being still at about the original level. The upper portion of the plain is everywhere of sand and gravel somewhat irregularly stratified.

The formation has a considerable extension in Greenfield Meadows and lesser ones to north and south. The gentle undulations of the surface, together with the lack of sharp stratification suggests that the sands were not laid down in standing water, but rather strewn here and there by the detritus-laden

floods from the melting ice on the hills, checked here in their steep descent, and arriving largely through the valleys of the Millers and Falls rivers.

FIG. 4.

Under the sands are clays observed at various levels from 190 to 270 feet above the sea. They rest on the glaciated sandstone, are beautifully stratified, occurring mostly in half-inch layers, greenish and butter-like, with gritty sandy layers from two to four inches thick between. They are exploited for brickmaking at several points in the escarpment around Montague Plain.

In the clay pits beside the track at Greenfield the stratification is clear and horizontal as elsewhere. but the upper surface of the clays, as revealed by the workmen, is uneven and not parallel to the stratification, while the transition from clay to

gravel is abrupt. At Keith's Spring (Fig. 1, *G*), 200 feet above sea, is a little hill of the laminated clays at the foot of the bluff, with its strata running squarely into the sand of the bluff across the intervening air. No other agency than the different rates of atmospheric wear on clay and sand is apparent to account for the notch between the clay hillock and the bluff. A similar hillock of laminated clays occurs half a mile further north. These three occurrences and the varying upper limit of the clays observed point to erosion of the clays before the sands were laid down. Yet in several of the sections the true surface may be masked by sand that has fallen down from above.

The present course of the Connecticut around the plain is of course postglacial and much of it is gorge cut in the rocks. Such rock-cutting is indicated on the map by heavy lines on the river margin. Though superposed on the rock structure underlying the plain this part of the river has now a certain adjustment to the structure as may be seen by the stratigraphic marks on Fig. 1 which indicate well-established facts.

Preglacially the channel was probably straight down from the northeast corner of the map by Millers Falls, and Lake Pleasant and thence westward to the present channel somewhere between *D* and *F*, points where ledges are now exposed.

Between the occupation of the ancient and modern channels there are indications of some persistence of the drainage across the plain by a west channel and an east channel. Indications of water passing through the west channel are:

(1) the gentle depression between *G* and *D* (Fig. 1), and (2) the frayed and waterworn state of a rock ledge at the 220-foot level (*D*), a hundred feet above the present river.

The east channel is better marked, being indicated today by deep sags in the plain at Millers Falls; kettles to the south, two of them occupied by the Lake Pleasant ponds; and the long deep valley to the south by which the lake drainage escapes to the river. The higher ground between the kettles is yet below the surface of the plain. This is shown in Fig. 7, taken

on the higher land between Lake Pleasant and the next kettle to north. The gentle hollow in the foreground represents the ground between the kettles. The tree tops in the middle dis-

FIG. 5.

tance indicate the location of the kettle.[1] Fig. 7 was taken to show that even if the kettles were filled up, there would still remain a shallow valley in the plain. The deeper southern por-

[1] This kettle, like the 100-foot cliff at *D* and some other features, does not appear on the Greenfield topographic sheet. The Lily Pond ridge also is quite misrepresented.

tion of the valley (at *E*) is in the clay, and brickyards are located there.

If the broad valley southwest from Turners Falls between the Greenfield trap ridge and the northwest bluff of Montague Plain was cut out by the modern river, it is remarkable that the cutting should have ceased a few feet above the rocks. But as

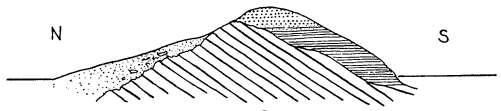

Fig. 6

these are beautifully glaciated and buried under a thin cover of drift, it is hard to believe the water has actually flowed over them. Moreover a curious remnant of sandplain (?) standing on the northwest corner of Montague Plain (at *C*) seems to indicate that ice filled this valley all through the building of the plain. The wearing back of the bluff has cut away most of this sandplain, but a section near Mr. Burnet's discloses the foreset beds and some of the topset. Sands on that side would have come from the hills to the northwest by the valley of the Falls River.

Kettles like those of the east valley we are wont to associate with drift-buried ice blocks. From the alignment with the old upper valley of the Connecticut, as seen in the northeast corner of the map, this chain of depressions might represent the burial in outwash sands of the decayed remnants of a valley ice tongue, the sands being supplied from the earlier revealed hills to north and east. The ice-tongue here however must have rested above the clays, unlike the tongue to the northwest. If this inference is correct, as the clay floor at *E* seems to make it, we must suppose the clays were laid down during a withdrawal of the ice-front from this area while it was either laked or depressed beneath the sea, and that subsequently the ice advanced again to southward, reaching its valley-tongue out over the clays where in the final melting of the ice it rolled

into a number of great fragments and was buried in the sands.

Chief attention is here called to the topographic facts which it is believed are accurately described. The succession of events

FIG. 7.

which seems most plausible is here offered as an hypothesis for present use. This hypothetical history is as follows:

1. Ice advance.
2. Ice retreat, leaving Turners Falls ice-tongue.
3. Deposition of clays.
4. Ice advance, east valley tongue overriding clays.
5. Ice retreat, leaving east valley ice tongue.
6. Building of Montague Plain and burying east valley ice.
7. Clearer waters pass through west valley.
8. Turners Falls valley ice melts, tempting Connecticut across the ridge where it cut successively Poag's Hole, Lily Pond and the Narrows.

9. East valley ice melts leaving modern topography.

10. The trenching river finds the rocks and cuts its gorge with present falls and rapids.

Ponds, such as those here described should be fairly numerous in glaciated regions. The kettle ponds are of course widely observed.

Pools of abandoned falls of glacial origin are not often cited. A superb example is noted by I. C. Russell[1] at the foot of a 400-foot basaltic cliff near Coulée City, Washington, over which the waters of the Columbia plunged when an ice dam drove them through the fault chasm of the Grand Coulée (p. 91). Another such pool is Thaxter Lake near Taylor's Falls, Minnesota, excavated by the tumbling waters of the deviated St. Croix.[2] Other fine examples are the Green Lakes at Jamesville and other points near Syracuse, reported by Gilbert and lately described by Quereau.[3] Here magnificent glacial outlets of Lake Iroquois, paralleling the Mohawk outlet, but farther south, cut broad trenches across the promontories of the ragged escarpment south of Syracuse and plunged Niagara-like into great basins below. The trenches are now dry high in the hills, but the basins are filled with placid greenish waters.

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[1] Bull. 108, U. S. Geol. Surv.

[2] Berkey, Am. Geol. Dec. 1897, p. 352.

[3] Bull. Geol. Soc. Am., Feb. 1898.